Physics 10154 - Exam #3b

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (40 pts) Block A is released from rest at the top of a 1.2 meter high frictionless curved path. It slides down and strikes block B, which is twice as massive as block A. Block B is initially at rest and the two blocks have an elastic collision. After the collision, block A rebounds and moves back up the curved path to what maximum height?

Block A slides down:

$$W_{grav} = \frac{1}{2}mv^2 - 0 \Rightarrow mgh = \frac{1}{2}mv^2$$

$$v = \sqrt{2gh} = 4.85\ m/s$$

Collision

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i} + \frac{2m_2}{m_1 + m_2} v_{2i}$$

$$= \frac{m - 2m}{m + 2m}(4.85) + 0$$

$$= -\frac{1}{3}(4.85) = -1.62$$

Block A slides up.

$$W_{grav} = 0 - \frac{1}{2}mv_0^2 \Rightarrow -mgh = -\frac{1}{2}mv_0^2$$

$$h = \frac{v_0^2}{2g} = \boxed{0.13\ m}$$

2. (30 pts) A 1.5 kg pendulum bob is attached to a 85 cm long string. The pendulum is held at rest with the string making a 35° angle with respect to the vertical and then released. What is the tension in the string when the pendulum reaches the lowest point of its motion?

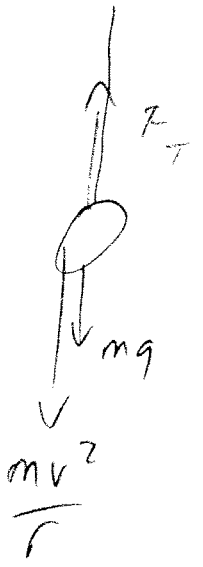
$$h = l - l\cos\theta$$

$$= 0.85(1 - \cos 35^\circ) = 0.154\ m$$

$$W_{grav} + W_T = \tfrac{1}{2}mv^2 - 0$$

$$mgh = \tfrac{1}{2}mv^2$$

$$v = \sqrt{2gh} = 1.74\ m/s$$



$$\Sigma F_{rad} = \frac{mv^2}{r} + mg - F_T = 0$$

$$F_T = mg + \frac{mv^2}{r}$$

$$= (1.5)(9.8) + (1.5)\frac{(1.74)^2}{.85}$$

$$= 14.7 + 5.3$$

$$= \boxed{20\ N}$$

3. (30 pts) A rocket is launched directly upwards from the surface of the Earth with an initial speed of 12,000 miles/hour. What maximum height above Earth's surface does the rocket attain, in miles? Remember, at such high speeds and large distances, the force of gravity is NOT constant.

$$U_i + K_i = U_f + K_f \qquad 12000 \tfrac{mi}{hr} = 5363\ m/s$$

$$U_i = -\frac{GM_E m}{R_E} = -\frac{(6.67\times10^{-11})(6\times10^{24})m}{6.38\times10^{6}}$$

$$= -6.27\times10^{7}\ m$$

$$K_i = \tfrac{1}{2}mv_0^2 = 1.44\times10^{7}\ m$$

$$U_f = -\frac{GM_E m}{r} = -\frac{4.0\times10^{14}\ m}{r}$$

$$K_f = 0$$

$$-6.27\times10^{7}\ m + 1.44\times10^{7}\ m = -\frac{4.0\times10^{14}\ m}{r} + 0$$

$$-4.83\times10^{7} = -\frac{4.00\times10^{14}}{r}$$

$$r = 8.28\times10^{6}$$

$$h = r - R_E = 1.90\times10^{6}\ m$$

$$= \boxed{1200\ miles}$$